Exploring methods for analyzing abnormal gait using portable devices

Akifumi Sugimoto[1], Syunpei Iwamoto[3], Hirofumi Hori[2], Mitsunori Matsushita[3]

[1]*Faculty of health science, Aino University, Japan,*
[2]*Faculty of Nursing and Rehabilitation, Konan women's University, Hyogo Japan ,*
[3]*Faculty of Informatics, Kansai University, Japan*

E-mail adless ; a-sugimoto@pt-u.aino.ac.jp

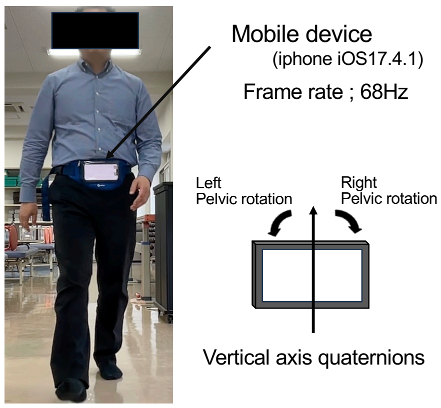
INTRODUCTION

With the recent evolution of mobile devices, methods to collect data on physical exercise using devices that are carried on daily have been attracting attention. In particular, sensors built into smartphones are readily available at low cost, making biometric measurements easy.

This study investigates differences in gait patterns based on a quaternion obtained by employing a mobile device as a motion sensor.

METHODS

Set up motion senser

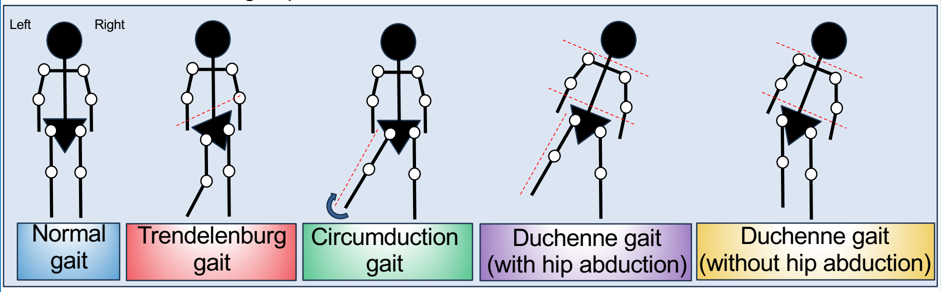


Analysis of the data

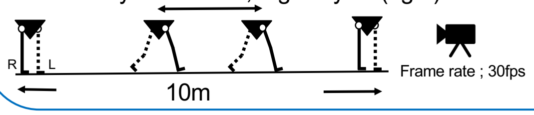
Subject ; 1 healthy adult (47 year old, 171cm,80kg)

Task ; five simulated gait patterns

Number of measurements ; 5 times



Analysis interval ; 1 gait cycle (right)



Extracted data ;

- Vertical axis quaternions, time (1gait cycle)
- steps (10m)

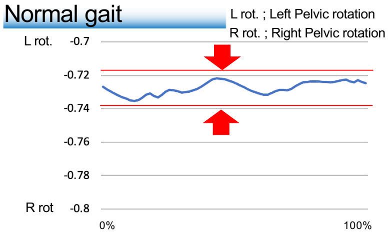
RESULTS

	Normal	Trendelenburg	Circumduction	Duchenne (with hip abduction)	Duchenne (without hip abduction)
1 gait cycle time (sec)	1.014±0.02	1.034±0.03	1.226±0.05	1.198±0.04	1.166±0.06
10m step count	16.2	19.4	19.8	23.4	26.6

Average of 5 times

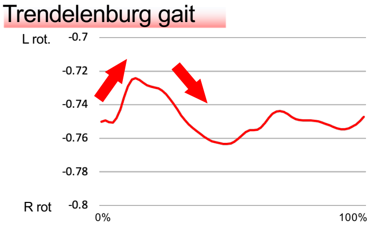
Vertical axis quaternions results

Normal gait



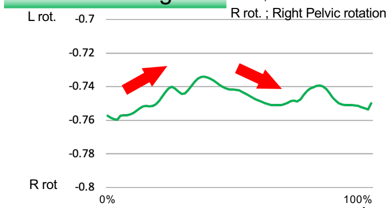
The left and right rotation of the pelvis is evenly executed with little variation in the data and small fluctuations.

Trendelenburg gait



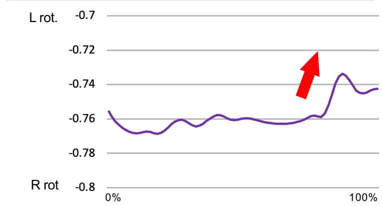
In the stance phase, right rotation occurs after an abrupt left rotation of the pelvis.
Rotational movement occurred with pelvic subduction movement in Trendelenburg gait.

Circumduction gait



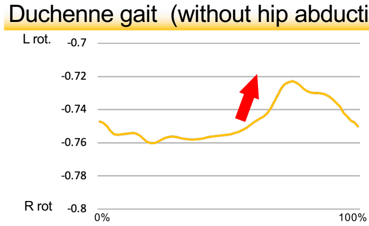
Of the five simulated gait, the time of one gait cycle is the longest.
Left pelvic rotation is present in the early stance phase.
It is possible that the left lower limb is swinging posterior.

Duchenne gait (with hip abduction)



Less change in pelvic rotation during the stance phase.
There is a quick pelvic left rotation at the end of the swing phase.
Possible delayed left pelvic rotation due to hip abduction and trunk lateral flexion.

Duchenne gait (without hip abduction)



Of the five simulated gait, 10m step count is the highest.
Less change in pelvic rotation during the stance phase.
The onset of right pelvic rotation is faster than that associated with hip abduction.

DISCUSSION

The quaternion results revealed the possibility of different patterns in different gait types. Although quaternions are not a direct indicator of rotational motion, they may be a valuable tool for understanding gait.

By pursuing these goals, we can develop a low-cost and efficient gait analysis method using mobile terminals, which can be used for early detection of abnormal gait, physical therapy evaluation, and as an educational tool.